HAMILTON
RANGEMASTER AM1000

AM1000

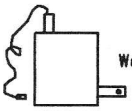
INSTALLATION INSTRUCTIONS

OUTSIDE TRANSMITTER

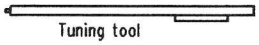
AM1000
213 CARAWAY LN
Cary NC 27519

With your AM1000 you should find:

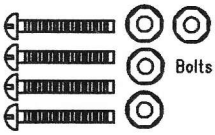
Some spare junper shunts



Wall transformer/ 12 volt power supply



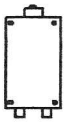
Tuning tool



Bolts and nuts

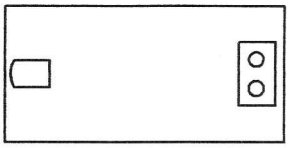
Crystal
(unless you ordered the agile module)

Ferrite

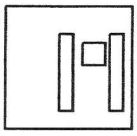


Transmitter

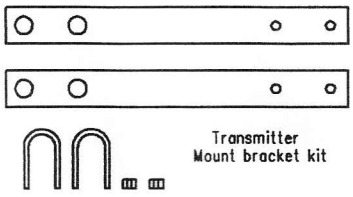
These items may or may not be included depending on what you discussed at the time of your order



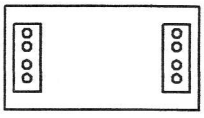
AM1000PR audio adapter



Frequency agile module



Transmitter
Mount bracket kit



Audio attenuator

Installing the AM1000 transmitter

This unit is meant to be installed by someone who has some radio background. If you don't feel qualified to install this unit yourself contact a local radio/TV shop. They may be able to help. Also if you have a friend who is a Ham radio operator they may be able to help you. The goal of a successful installation is to achieve ½ mile range if the unit is near ground level. Within this ½ mile the signal should be clear and easy to hear. There may be some static mixed in, but the message being played should be clear. Up to a mile range and further may be possible if you have a good site and have the unit higher. A good height is 30 feet.
Look around the structure and find a suitable place to mount the transmitter. It should be mounted as high as possible. Keep in mind the cabling needs, a cable needs to run to the power and audio source. See included diagram for cabling example. Typically #24 2 pair shielded cable is used for runs of 50 feet or less, #22 for up to 100 feet. Use one pair for + and – 12 volt and the other pair for the 600 ohm balanced audio. Connect the shield to ground at just one end. Also a ground wire needs to be run from the transmitter to a good ground for lightning protection. You can drive a 4 or better 8 foot ground rod into the ground for the lightning protection ground or use an existing ground. For best lightning protection the ground wire should have a direct path to dirt ground. If you get low range and the tuning peak voltage range is low you may have a bad ground. Driving an 8 foot rod into soil should insure you have a good ground. An electrical or pipe ground may not be reliable.
RF (radio frequency) can be tricky stuff. If you don't get results from your site, try another. The height is very important. The unit will not work unless it is tuned after it is installed in its final position. (You can't tune it on the ground first, it HAS to be tuned after everything is done, wires tacked into position.
Avoid putting the antenna near metal, especially large massive pieces of metal. Small metal pieces may be all right. You want to provide a stable environment around the unit. You can change its environment by moving metal around close by. Metal that is connected to ground has a higher effect on the transmitter. Be sure to tell the customer or keep in mind if you are installing it yourself that if the transmitter or antenna or ground wire is moved, the unit will not work correctly and will need to be re-tuned. Attach any ground wire so that it will not move in the wind.

The antenna develops hundreds of volts of RF power. It won't shock you and can easily be quenched by even putting your hand close to it.
Once you've found a site sturdily mount the unit to the structure. Cable the ground wire to a good ground. Use #12 or #10 wire or larger (not aluminum) and run the wire directly down to your ground rod. The ground wire connects to the black binding post on the bottom of the unit. If your wire is to large to fit into the binding post use a short section of #12 wire and a wire nut to complete the connection. Weatherproof the wire nut connection. It is important to keep the ground wire away from metal on the way to ground rod to get good range and provide the best lightning protection. Keep the ground wire away from other metal if at all possible. (See hints page) A couple inches away is fine. Cable the unit to the inside to provide power and audio for the transmitter. See included diagram. The unit requires a 102" whip antenna that can be purchased at Radio Shack, Stock # 21-903. It can be steel or fiberglass. Some say the fiberglass will give slightly better range. The striped wire is plus on included wall power supply.
Begin the Tuning: You will need the following
VOM Meter Tuning tool (supplied)
Small flathead screwdriver Medium Phillips screwdriver
The VOM or volt ohm meter can be bought at a Radio Shack. The analog type or non digital is preferred. Be sure the crystal is installed if you are not using the agile module.
The crystal will not lock into the board, just seat it into the socket pins, it won't fall out.
Check that "TUNE" is set 1/2 way between the counter- clockwise position (Min. Capacitance) and clockwise position (Max. Capacitance). Use the tuning tool to tune. When "TUNE" is turned fully either way be careful not to apply to much force. Permanent damage may result. "TUNE" will turn about 10 turns. Make sure that the "Power Adjust" control is set to about 1/2 of the way from counter clockwise. It may be a 1 turn or 10 turn control. Set "AUDIO LEVEL" all the way down (counter – clockwise). Important Note: (TURN IT BACK UP WHEN YOU ARE DONE TUNING!) (This is a commonly missed item)
Set the "POWER SWITCH" to on. "Cabling note, you can use either terminal block for cabling they are both the same, (+ and – is for power NOT S+ and S-, AF+ and AF- is audio)" Check all of your cabling, turn the power on. You should be able to see the power light come on. See cable diagram in this Manual for cabling examples. When using the Ferrite if the hole is to big try to loop the cable through twice. The ferrite installs on the audio cable just outside the transmitter box.
Step 3
There are 3 test hole pads on the unit (see diagram). Take a standard voltmeter that is set to a low DC range (10 – 20 volts) and plug it into the bottom and top test hole pads. The black lead will go to the test hole pad closest to the mounting hole (Ground).
Next move the jumper on the "COIL TUNE" jumper block one at a time to find the one that gives the highest meter reading or highest power amp voltage. Be sure that only one jumper is used at a time. Leave this jumper on the highest meter reading and proceed.If you find 2 areas of the jumper block that give a peak reading one of them may be an harmonic. Chose the position closest to the center of the jumper block range. If you are not seeing a good meter reading then rotate the PWR control until you do, or check your meter.
Step 4

If things look good so far take the tuning tool and rotate "TUNE" to obtain a peak reading of the meter. When the meter peaks you are tuned. Be sure to stay away from the antenna while tuning. If you are to close to the antenna your body will affect where it tunes.
Keep in mind that you need to see a peak. The meter should rise and fall as you adjust. If you just turn it clockwise or counter clockwise all the way and the meter goes up until the capacitor can't be turned anymore then it is not tuned.

You will get the most power with the least capacitance of the tuning cap that you can get to tune (counter clockwise). You may find that 2 jumper positions will tune. If so use the one that tunes with the "TUNE" in the most counter clockwise or least capacitance position. This will give you the best range and circuit performance.

Step 5

The next step is to adjust the power level. This can be tricky for some people and simply involves taking 2 voltage readings and multiplying them. (Referring to the chart in this manual will help) The result will be your power in Watts. Turn the audio pot all the way down. Once you are sure that you have a peak in the meter take note of what the power amp voltage is. For example it may be 1 Volt. Now place your Black (negative) test lead in the bottom test hole pad & your Red (Positive) test lead in the middle test hole pad. This will measure your power amp current. The conversion is 1 volt = 100 milliamps or .1 Amp. Let's say for example that the voltage here is 1 volt. Then 1 volt times .1 Amp =.1 Watt, you have 100 milliwatts. Your power should not exceed 100 milliwatts or .1 Watt to comply with FCC rules (Part 15).
1 volt power amp voltage times 1 volt power amp current (.1 Amp) = .1 Watt or 100 milliwatts.
1 X .1 = .1 Watt. Voltage times Current equals Power.
This would be acceptable. See the conversion table supplied for different combinations of power amp voltage and current that equal 100 milliwatts. The "Power Adjust" works just like a volume control. Clockwise is more power and counter clockwise is less. Adjusting the "Power adjust" will affect "Tune" adjustment slightly, you will want to go back and tweak "Tune" for a peak voltage as detailed earlier.

Step 6

Next connect your audio source. It is a good idea to leave the "aud" audio adjust ¾ to all the way up "clockwise" and adjust the audio level from the ground. The Terminal block input is designed to work with a 600 ohm telephone cable like impedance. When you order the AM1000 you get an adapter that will convert 8 ohm (low imp 3.5mm) speaker type output or (high imp) like from a CD player to the required 600 ohm balanced audio. The new audio adapter has a gain control.

Step 7

Using a test radio tune to the transmitter frequency. The frequency used for this unit is often 1610 Khz . If the frequency is different it will be marked inside the unit. Look on the crystal (Y1). Once you pick up the signal on your test radio, (with no audio it will sound quiet with maybe a slight hum. Turn up your "AUDIO LEVEL" while listening to the test radio until you get distortion then back the "AUDIO LEVEL" off just a tad. If you are adjusting the audio level from the ground leave the "AUDIO LEVEL" set about ¾ position. Your station should sound as loud as others in your area on a test radio, if you don't then there is a problem.

A scope is needed to be sure of 100% modulation. When the unit is being 100% modulated a test sine wave at the antenna will match the original waveform.

Step 8

Now go and check your range. Use your car and your odometer to check the range. Do the final tune on "TUNE" (Check to be sure the power amp voltage is still peaked). Adjust "AUDIO LEVEL" control for best sound on your radio. Give the customer any paperwork that you need to give them and tell them the frequency that the unit is on.

Keeping the antenna as vertical as possible will help your range. It is also critical to keep the antenna away from metal. Don't for example, mount the antenna so it runs 1/8 inch from, parallel to a metal drain pipe.

Before you leave make sure that the customer knows that if they have any trouble with the transmitter to simply unplug the wall transformer or power supply. Because of the high RF voltage generated the unit can induce a signal into phone lines, stereos, and other equipment. The most often problem is with the phone line. Check their phone by getting rid of the dial tone and listening for a recorded test message. If it is there and it bothers them you could try to put the unit in a site further from any phone lines or you could adjust "POWER ADJUST" on the unit down or counter clockwise. If you turn the power down make sure that the range is still acceptable. With some sites it may be possible that you can't put the unit in because of RF susceptible phone lines or other equipment.

If you find that you are not getting good range check the transmitter ground system, if you notice that when tuning the unit that instead of a sharp peak in the voltage the voltage barely moves while you are tuning you probably have a bad ground. Electrical grounds will not always be acceptable, you may need to run a separate ground or find another ground. You could use a water pipe that is going to ground for example. Also if you are getting poor range make sure you have set the power properly. If you are having troubles recheck all wiring and connections. If you have carrier but no audio be sure the audio pot is turned up. Be sure the power is connected to the power terminals and not the sync terminals. Be sure the crystal is in and seated (unless you have the freq module).

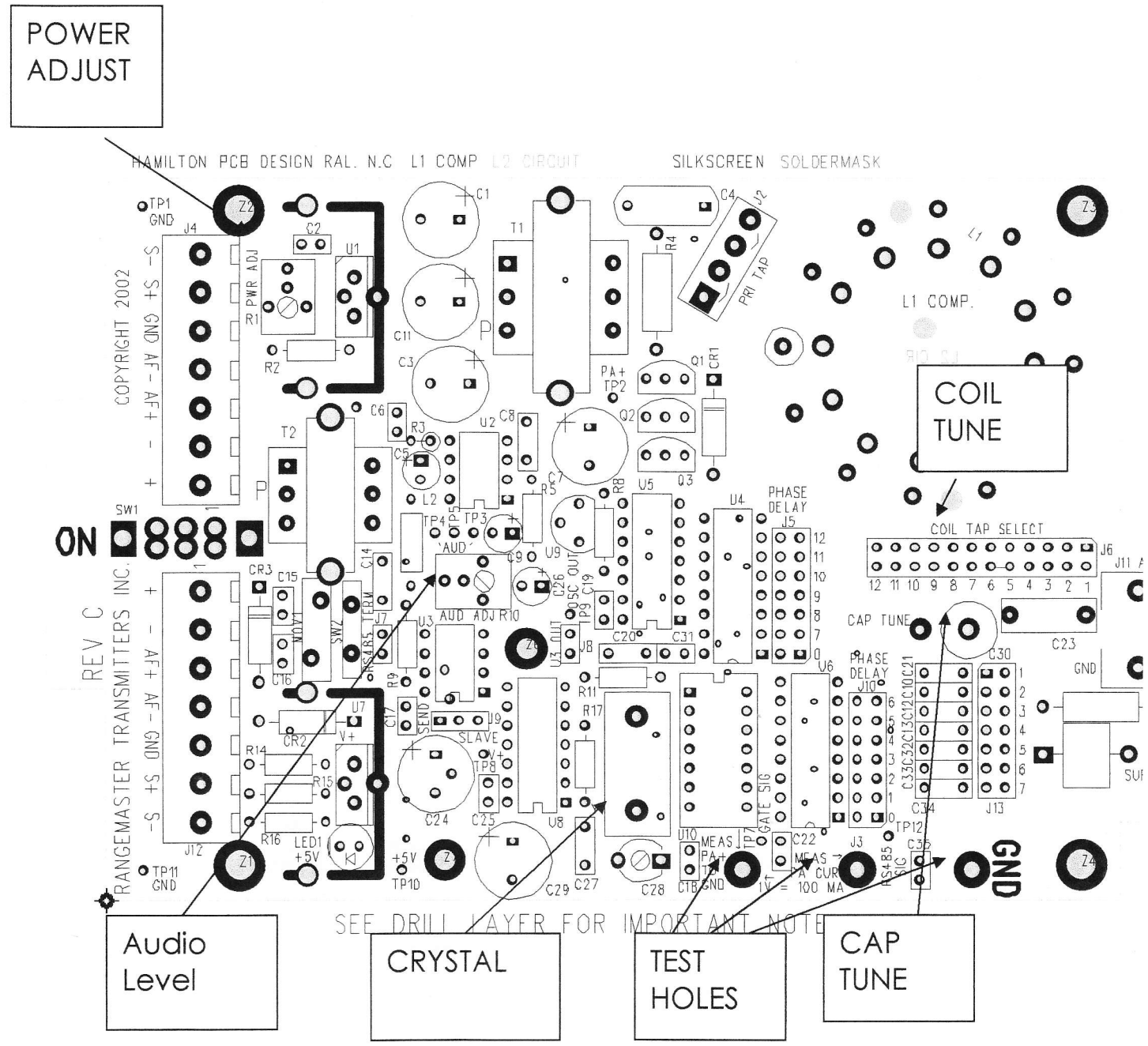
Section 15.219 Operation in the band 510 - 1705 kHz.

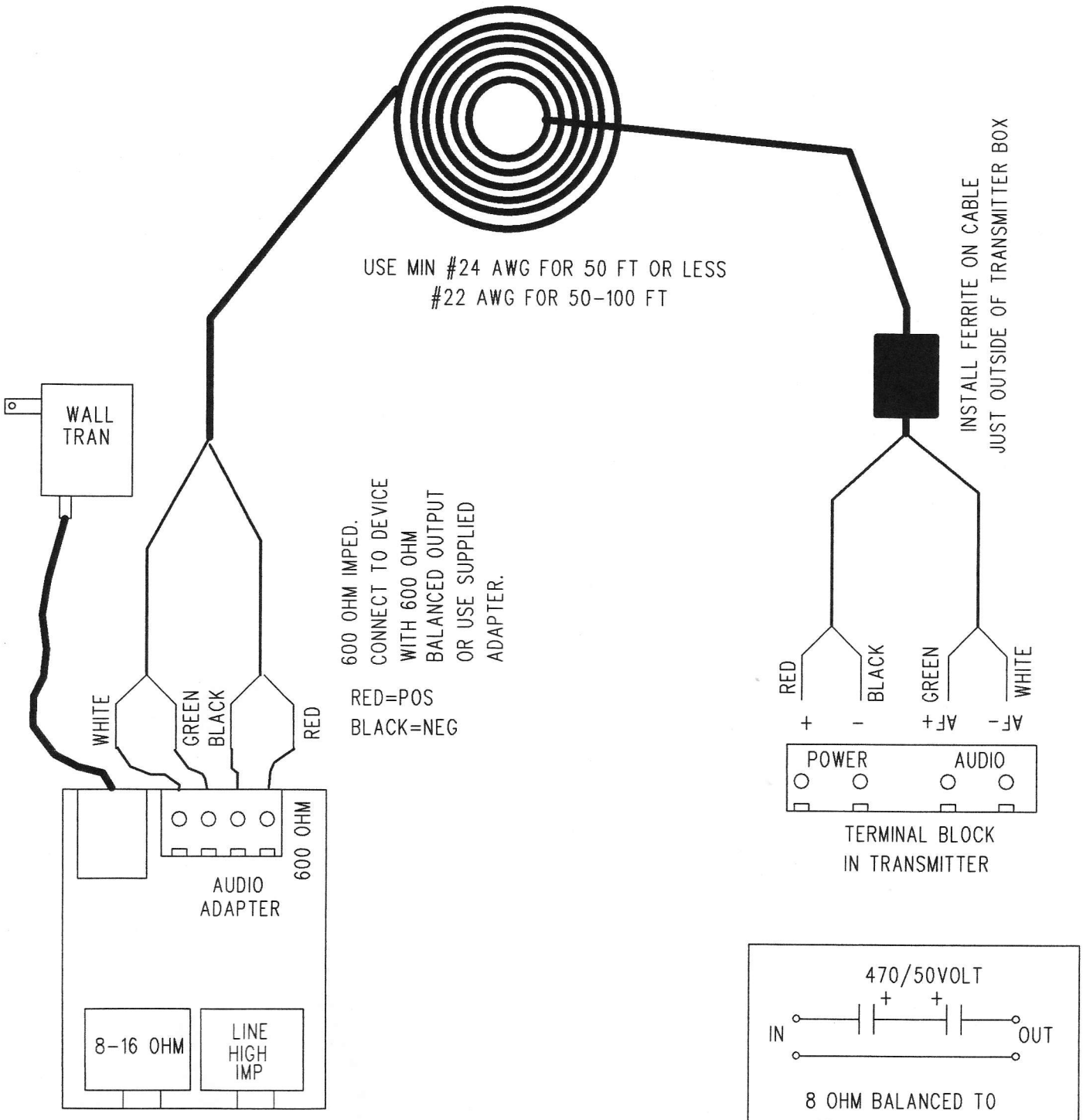
(a) The total input power to the final radio frequency stage (exclusive of filament or heater power) shall not exceed 100 milliwatts.

(b) The total length of the transmission line, antenna and ground lead (if used) shall not exceed 3 meters.

(c) All emissions below 510 kHz or above 1705 kHz shall be attenuated at least 20 dB below the level of the unmodulated carrier. Determination of compliance with the 20 dB attenuation specification may be based on measurements at the intentional radiator's antenna output terminal unless the intentional radiator uses a permanently attached antenna, in which case compliance shall be demonstrated by measuring the radiated emissions.

We recommend fully cooperating with the FCC and following all FCC rules. The FCC is an independent governmental agency, answerable only to congress, we cannot guarantee and/or we cannot be held responsible for what the FCC may do or decide in any particular situation.


POWER ADJUST
HAMILTON PCB DESIGN RAL. N.C L1 COMP L2 CIRCUIT SILKSCREEN SOLDERMASK
COPYRIGHT 2002
RANGEMASTER TRANSMITTERS INC.
REV C
ON
L1 COMP.
COIL TUNE
COIL TAP SELECT
CAP TUNE
PHASE DELAY
GND
Audio Level
CRYSTAL
TEST HOLES
CAP TUNE
SEE DRILL LAYER FOR IMPORTANT NOTE



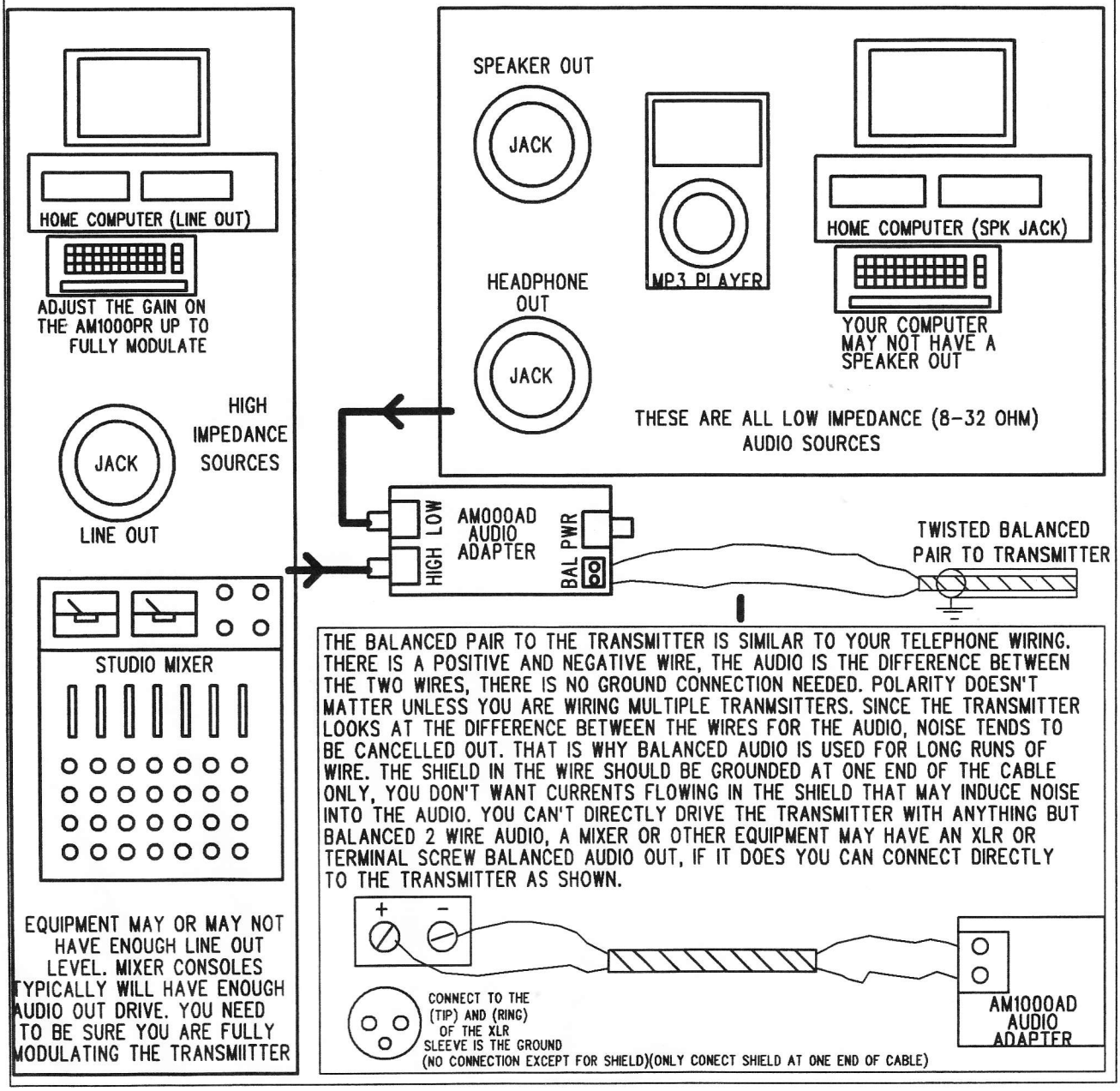
8 OHM BALANCED TO
600 OHM BALANCED
ADAPTER

USE THIS CIRCUIT TO DRIVE
600 BALANCED WITH 8 OHM
SPEAKER OUTPUT
WITHOUT ADAPTER

ANOTHER SUITABLE 14-18VDC SOURCE MAY BE USED

RANGEMASTER CABLE DIAGRAM

We have found the most common cause of low range is the audio setup, even more common then grounding problem. Not enough audio power (volume) and/or an impedance mismatch. If you are using an 8 ohm (low impedance) output which would be a headphone or speaker output that needs to be connected to the low impedance input on the audio adapter. Then the 2 screw terminal block needs to be wired via 2 wire twisted pair to the transmitter. If you plug the low impedance port of the adapter to a high impedance source like a line out jack you will have problems. An impedance mismatch will lower the audio level and reduce the fidelity, and may cause distortion. If you have a line out type source it needs to go to the high impedance jack on your audio adapter. In either case if you can't get the audio loud enough so it is as loud as other stations in your area without distortion then there is a problem in the audio chain.


HOME COMPUTER (LINE OUT)
ADJUST THE GAIN ON THE AM1000PR UP TO FULLY MODULATE
JACK
HIGH IMPEDANCE SOURCES
LINE OUT
STUDIO MIXER
EQUIPMENT MAY OR MAY NOT HAVE ENOUGH LINE OUT LEVEL. MIXER CONSOLES TYPICALLY WILL HAVE ENOUGH AUDIO OUT DRIVE. YOU NEED TO BE SURE YOU ARE FULLY MODULATING THE TRANSMIITTER
SPEAKER OUT
JACK
HEADPHONE OUT
JACK
MP3 PLAYER
HOME COMPUTER (SPK JACK)
YOUR COMPUTER MAY NOT HAVE A SPEAKER OUT
THESE ARE ALL LOW IMPEDANCE (8-32 OHM) AUDIO SOURCES
HIGH LOW
AM000AD AUDIO ADAPTER
BAL PWR
TWISTED BALANCED PAIR TO TRANSMITTER
THE BALANCED PAIR TO THE TRANSMITTER IS SIMILAR TO YOUR TELEPHONE WIRING. THERE IS A POSITIVE AND NEGATIVE WIRE, THE AUDIO IS THE DIFFERENCE BETWEEN THE TWO WIRES, THERE IS NO GROUND CONNECTION NEEDED. POLARITY DOESN'T MATTER UNLESS YOU ARE WIRING MULTIPLE TRANMSITTERS. SINCE THE TRANSMITTER LOOKS AT THE DIFFERENCE BETWEEN THE WIRES FOR THE AUDIO, NOISE TENDS TO BE CANCELLED OUT. THAT IS WHY BALANCED AUDIO IS USED FOR LONG RUNS OF WIRE. THE SHIELD IN THE WIRE SHOULD BE GROUNDED AT ONE END OF THE CABLE ONLY, YOU DON'T WANT CURRENTS FLOWING IN THE SHIELD THAT MAY INDUCE NOISE INTO THE AUDIO. YOU CAN'T DIRECTLY DRIVE THE TRANSMITTER WITH ANYTHING BUT BALANCED 2 WIRE AUDIO, A MIXER OR OTHER EQUIPMENT MAY HAVE AN XLR OR TERMINAL SCREW BALANCED AUDIO OUT, IF IT DOES YOU CAN CONNECT DIRECTLY TO THE TRANSMITTER AS SHOWN.
+
-
CONNECT TO THE (TIP) AND (RING) OF THE XLR
SLEEVE IS THE GROUND
(NO CONNECTION EXCEPT FOR SHIELD)(ONLY CONECT SHIELD AT ONE END OF CABLE)
AM1000AD AUDIO ADAPTER

If you are using an Innovonics 222 be sure your output polarity is correct, here is how:
1. Turn the positive peaks all the way down
2. Turn the output level up until you get distortion, then back off a little (hair) for good sound.
3. Then turn the positive peaks all the way up, if you get distortion then the (output) terminals + and - are probably reversed.
The polarity of the input terminals doesn't matter.
If you are having trouble matching your input impedance to the Innovonics see the website for instructions. (How to hints, then audio button)

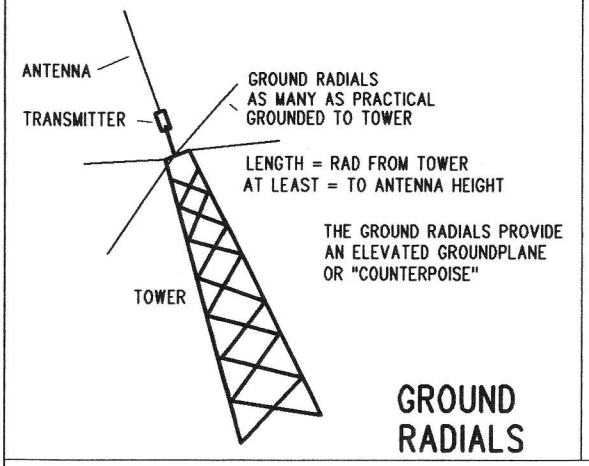
-Your station should sound as loud as others on the dial, if it doesn't there is a problem. It may be an audio impedance mismatch, or the level may need to be turned up. If the audio level isn't high enough you won't get good range, audio is a gate on the power, keep your audio turned up as high as you can.

-We have found the most common cause of low range is the audio setup, even more common then grounding problems. Not enough audio power (volume) and/or an impedance mismatch. If you are using an 8 ohm (low impedance) output which would be a headphone or speaker output that needs to be connected to the low impedance input on the audio adapter. Then the 2 screw terminal block needs to be wired via 2 wire twisted pair to the transmitter. If you plug the low impedance port of the adapter to a high impedance source like a line out jack you will have problems. An impedance mismatch will lower the audio level and reduce the fidelity, and may cause distortion. If you have a line out type source it needs to go to the high impedance jack on your audio adapter. In either case if you can't get the audio loud enough so it is as loud as other stations in your area without distortion then there is a problem in the audio chain.

To get more Range:
Try to locate the transmitter near something that will reradiate the RF energy such as high tension power lines. The signal will tend to follow lakes and rivers. Use as high a modulation level as you can. Get the unit as high as you can but not so high you can't safely get to it to tune it.

Troubleshooting:
-Check the voltage at the terminals of the transmitter, is there at least 12VDC there?
-Low range is often a bad ground. There could be bad soil conductivity in your area, or the ground rod could just be in gravel or sand instead of dirt. If you can just push the rod in with your hand then it won't be a good ground. Bad connections are often the problem. Just wrapping wire around a rod will NOT work. ALL connections need to be soldered or clamped. The copper needs to be bright and shinny before soldering or clamping. Be sure your ground wire is isolated and not wrapped around a metal mast or attached to metal siding or downspout. The ground wire should be isolated from all massive (bigger then a nail) metal. Use an 8 foot ground rod if at all possible. If you are using bigger then #12 wire (better) you won't be able to insert it into the binding post at the transmitter. Use a short (6") piece of #12 as a splice make the connection. Twist the #12 wire to the larger wire and twist a wire nut on. Be sure to weatherproof this with some silicone. Then put the other end into the ground binding post of the transmitter and tighten the binding post. If you find that you installation degrades after a few weeks you probably have a ground splice or connection that is weathering or corroding somewhere. This ground wire must be locked down and stable so it won't move. Electrical grounds will not always be acceptable, you may need to run a separate ground or find another ground. You could use a water pipe that is going to ground for example. See the hints page for an example of a good ground system.

-Check quality of ground- After tuning unit, with the tune voltage at about 2-3 volts (rotate PWR) rotate the Cap tune from the extreme counter clockwise position to the clockwise position while watching the meter. Make note of the voltage swing you see, less then 1.5 volt, bad or no ground. 1.5-2 volts poor to adequate ground. 2-3 volts, good ground. 3-5volts, great ground. This test will give you an idea where you stand with your ground quality.
-If you are getting poor range be sure you are setting the power properly.
-If you have carrier but no audio be sure the audio pot is turned up. Be sure the power is connected to the power terminals and not the sync terminals.
-Be sure the crystal is in and seated (unless you have the freq module).
-Is power switch on?
-Are you using the tuning tool provided?
-When the transmitter is working properly it is possible to see a small spark with a pencil lead placed close to the coil (large red round object) pins. You may need to turn the power up for it to do this. Or you may feel a slight RF burn to your finger if you lightly touch the pins of the coil.



GROUND RADIALS

IF YOU AREN'T USING A TOWER SIMPLY MOUNTING THE TRANSMITTER OVER A GROUNDPLANE OR ELEVATED GROUNDPLANE WILL HELP. THIS CAN BE AS SIMPLE AS INSTALLING THE TRANSMITTER OVER A BUILDING THAT HAS A METAL ROOF. DESIGNING AN GROUNDPLANE IS COVERED ELSEWHERE ON THIS SITE.
THE TRANSMITTER DOES REQUIRE A GOOD GROUND TO OPERATE, IT CAN BE AS SIMPLE AS USING THE EXISTING ELECTRICAL GROUND OR VERY COMPLEX AS WHEN USING MULTPLE GROUND RODS AND BURIED RADIALS.

IF YOU TRY TO USE THE EXISTING ELECTRICAL GROUND OF A BUILDING YOU MAY NEED AN ELECTRICIAN.

ANY GROUND YOU USE MUST BE ELECTRICALLY CONDUCTIVE. FOR EXAMPLE, IF YOU USE A METAL ROOF CHECK TO BE SURE IT IS ELECTRIALLY CONDUTIVE ACROSS IT'S SURFACE.

ONE OF THE BEST WAYS TO GET MORE RANGE TO TO TAKE ADVANTAGE OF THE AM1000'S ABILITY TO BE MODULATED +130%. THERE ARE MANY AUDIO PROCESSORS ON THE MARKET THAT WILL DO THIS, THE CHEAPEST IS THE INNOVONICS 222. SEE INOVON.COM THE OPTIMOD IS ALSO AN EXCELLENT UNIT.
ANOTHER TIP FOR GETTING GOOD RANGE IS TO OVER MODULATE A BIT.

Section 15.219 Operation in the band 510 – 1705 kHz.

(a) The total input power to the final radio frequency stage (exclusive of filament or heater power) shall not exceed 100 milliwatts.

(b) The total length of the transmission line, antenna and ground lead (if used) shall not exceed 3 meters.

(c) All emissions below 510 kHz or above 1705 kHz shall be attenuated at least 20 dB below the level of the unmodulated carrier. Determination of compliance with the 20 dB attenuation specification may be based on measurements at the intentional radiator's antenna output terminal unless the intentional
radiator uses a permanently attached antenna, in which case compliance shall be demonstrated by measuring the radiated emissions.

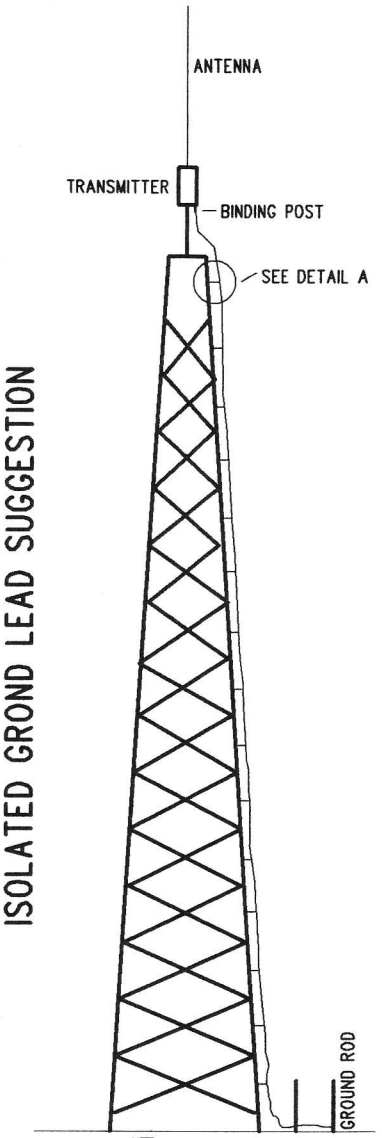
Always cooperate with the FCC and follow FCC law.
Note: The FCC may not pass some of the grounds on this page (ex elevated ground).

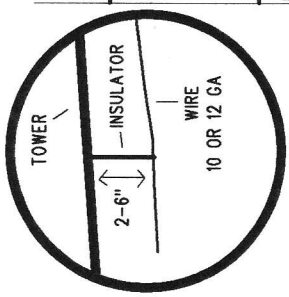
ANOTHER TRICK IS TO KEEP IN MIND THAT ANY CONDUCTOR IN THE AIR THAT ISN'T GROUNDED WILL CARRY YOUR SIGNAL. HIGH TENSION POWER LINES CAN CARRY YOUR SIGNAL FAR IF YOU CAN INDUCE YOUR SIGNAL INTO THEM. EVEN YOUR BACKYARD CLOTHESLINE CAN ACT AS A RADIATOR IF IT IS METAL WIRE AND HAPPENS TO BE INSULATED AT THE ENDS. YOUR SIGNAL CAN BE BE PICKED UP AND RE-RADIATED.
KEEP THIS IN MIND & LOOK FOR CONDUCTORS LIKE THIS WHEN LOOKING FOR A SITE FOR YOUR LOW POWER TRANSMITTER.

ANOTHER HINT IS WATER. YOUR SIGNAL WILL CARRY WELL OVER OPEN WATER.

HEIGHT IS VERY IMPORTANT, BUT DON'T GET THE UNIT SO HIGH THAT YOU CAN'T GET TO IT TO TUNE IT PROPERLY.
IT'S IMPORTANT THAT IT BE HIGH, BUT IT'S CRITICAL THAT IT BE TUNED. THE UNIT WON'T WORK AT ALL IF IT'S NOT TUNED PROPERLY.
25-30 FEET IS USALLY GOOD FOR HEIGHT, MORE WILL GET MORE RANGE BUT THE MOST BANG FOR THE BUCK IS 25-30 FEET.

ISOLATED GROND LEAD SUGGESTION





DETAIL A

INSULATOR CAN BE CERAMIC OR ANY GOOD STRONG NON-CONDUCTIVE MATERIAL. PLASTIC WOULD BE OK.

TO GET GOOD RANGE:

1- ELEVATED GROUDPLANE
2- GET IT HIGH.
3- USE AN AUDIO PROCESSOR.
4- USE ISOLATED GROUND LEAD
5- ELEVATED OR BURIED RADIALS

RANGEMASTER Transmitters

Drawn	KFH
Date	6/04
Approv.	
Size	A
Scale	1x
Page	1 of 1

FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554
GRANT OF EQUIPMENT AUTHORIZATION
Certification

Hamilton PCB Design 213 Caraway Lane Cary NC 27519

Date of Grant: 07/17/1998 Application Dated: 05/08/1998
Attention: Keith Hamilton
NOT TRANSFERABLE

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

FCC IDENTIFIER: **NWXAM1000**
Name of Grantee: **Hamilton PCB Design**
Equipment Class: **Part 15 Low Power Communication Device Transmitter**
Notes:

Grant Notes	FCC Rule Parts	Frequency Range (MHZ)	Output Watts
	Frequency Tolerance	Emission Designator	
37	15	1.2 - 1.71 %	

E	I
1.0	1.00
1.1	.910
1.2	.840
1.3	.770
1.4	.720
1.5	.670
1.6	.630
1.7	.590
1.8	.560
1.9	.530
2.0	.500
2.1	.480
2.2	.455
2.3	.435
2.4	.420
2.5	.400
2.6	.385
2.7	.370
2.8	.360
2.9	.345
3.0	.335
3.1	.325
3.2	.315
3.3	.305
3.4	.295
3.5	.285
3.6	.280
3.7	.270
3.8	.265
3.9	.255
4.0	.250
4.1	.245
4.2	.240
4.3	.233
4.4	.228
4.5	.223
4.6	.218
4.7	.213
4.8	.210
4.9	.205
5.0	.200
5.1	.197
5.2	.193
5.3	.189
5.4	.186
5.5	.183
5.6	.180
5.7	.177
5.8	.174
5.9	.171

VOLTAGE

CURRENT

BOTTOM AND TOP TEST JACKS

MIDDLE AND BOT TEST JACKS

1.00 VOLT EQUALS 100 MILLI AMPS ACTUAL CURRENT

READINGS NEEDED THAT PRODUCE 100 MILLIWATTS